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10ME/AU52

Fifth Semester B.E. Degree Examination, June/July 2017
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of design data hand book is permitted.

PART – A

1 a. Identify the following materials from their designation and indicate the compositions:
(i) X10Cr18Ni9S3 steel (ii) SG 400/12 C.I. (iii) C35Mn75 steel. **(03 Marks)**

b. The state of stress in a planar member is as shown in Fig. Q1 (b). The maximum principal σ_1 stress in member is known to be 80 MPa. Determine (i) Shear stress τ_{xy} (ii) Max. shear stress τ_{max} and (iii) Minimum principal stress (σ_2). **(06 Marks)**

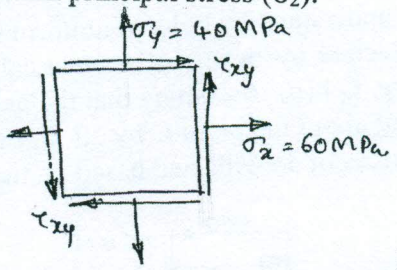

Fig. Q1 (b)

c. A bracket with rectangular cross section shown in Fig. Q1 (c) is subjected to a force of 5 kN, (P) acting at angle of 30° to the vertical. Determine the dimensions (t) of the bracket, taking the material as FG 200 cast iron and factor of safety 3.5, determine the dimensions of the cross section of bracket. **(11 Marks)**

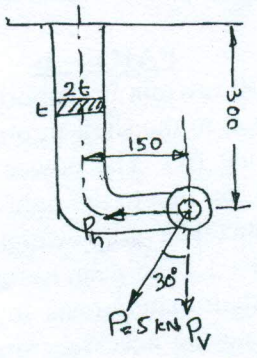

Fig. Q1 (c)

2 a. State 5 different theories of failure and explain any two. **(05 Marks)**

b. A bolt made of steel FeE_{200} is subjected to an axial load of 1500 N, and a shear force of 100 N, along with a twisting moment of 15 N-m as shown in Fig. Q2 (b). If the bolt diameter is 12 mm, what will be the factor of safety according to (i) maximum principal stress theory (ii) Maximum shear stress theory. Bolt length is 100 mm. **(09 Marks)**

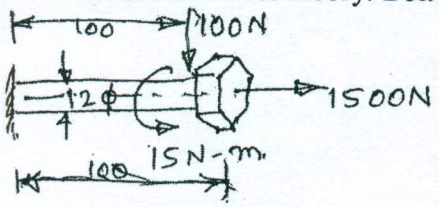

Fig. Q2 (b)

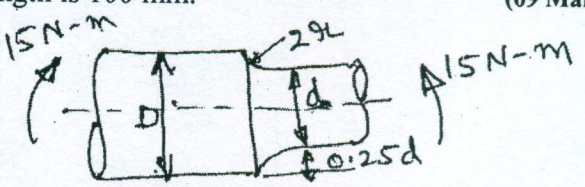

Fig. Q2 (c)

c. A round shaft made of ordinary Grey C.I. FG 200 is subjected to a bending moment of 15 N-m as shown in Fig. Q2 (c). The theoretical stress concentration factor at the fillet is 1.5. Determine the diameter 'd' and the maximum stress at the fillet. **(06 Marks)**

3 a. Derive the soderberg equation for members subjected to fluctuating stresses. **(06 Marks)**

b. A cantilever beam made of carbon steel of circular cross section shown in Fig. Q3 (b) is subjected to a load which varies from (-F) to (+3F). Determine the maximum load that this member can withstand for an infinite life using factor of safety '2'. Theoretical stress concentration factor of $K_t = 1.42$ and notch sensitivity of 0.9 may be used, with following stresses. (i) Ultimate strength $\sigma_u = 550$ MPa, Yield strength $\sigma_y = 470$ MPa. Assume endurance strength as 0.5 times ultimate strength (σ_u) and other correction factors for endurance strength suitably. **(14 Marks)**

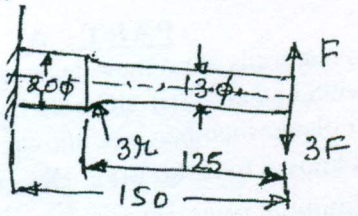

Fig. Q3 (b)

4 a. Explain what do you understand by bolts of uniform strength. **(06 Marks)**

b. A wall bracket is attached by means of 4 identical bolts, two at 'A' and two at 'B' and loaded as shown in Fig. Q4 (b). Assuming that the bracket is held against the wall firmly and prevented from tipping about the point C by all four bolts, determine the size of bolts taking an allowable tensile stress of 35 MPa and based on the maximum principal stress theory. **(14 Marks)**

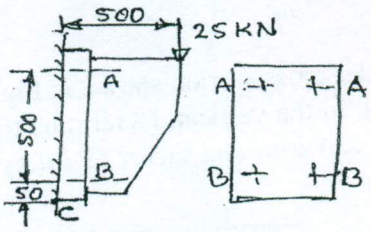

Fig. Q4 (b)

PART – B

5 A machine shaft running at 600 rev/min is supported on bearings 750 mm apart as shown in Fig. Q5. Fifteen KW is supplied to the shaft through a 450 mm. Pulley (P) located 250 mm to the right of the right bearing (R). The power is given away from the shaft through a 200 mm spur gear (G) located 250 mm to the right of the left bearing (L). The belt drive is at angle of 60° above the horizontal. The pulley weighs 800 N to provide some flywheel effect. The ratio of belt tensions is 3 : 1. The gear has a 20° tooth form and mates another gear located directly above it. The shaft material has an ultimate strength of 500 MPa and a yield strength of 310 MPa. Determine the necessary diameter of shaft as per ASME standards. Take the load factors in bending and torsion as 1.5 and 1.0 respectively and also keyway effects due to mounting of gear and pulley. The shaft rotates CCW looking from left as shown. **(20 Marks)**

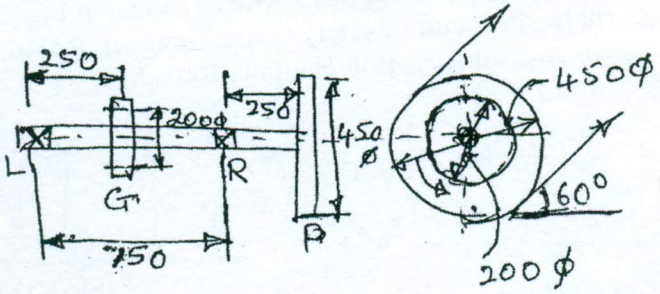

Fig. Q5

6 a. Design a knuckle joint to connect two circular rods subjected to an axial load of 50 KN. The rods are co-axial and a small angular movement between their axes is permissible. Assume the strength of the rods and pin same in tension and compression and equal to 400 MPa(σ_y) and shear strength is to be taken as 0.5 times yield strength. Factor of safety is 5. Also write a neat sketch of the assembly. **(08 Marks)**

b. It is required to design a protected type rigid flange coupling to connect two shafts. The shaft transmit 37.5 kW at 180 rev/min to the output shaft through the coupling. Starting torque is 1.5 times rated torque. The shafts and keys are made of steel with yield strength $\sigma_{yt} = 380$ N/mm^2 with a factor of safety 2.5. Flanges are made by C.I. FG 200 with a factor of safety 6. Assume ultimate shear strength as one half of the ultimate tensile strength. Also draw a sketch of the coupling. **(12 Marks)**

7 a. A welded connection as shown in Fig. Q7 (a) is subjected to an eccentric force of 7.5 kN. Determine the size of weld if the permissible shear stress for the weld is limited to 100 MPa. **(10 Marks)**

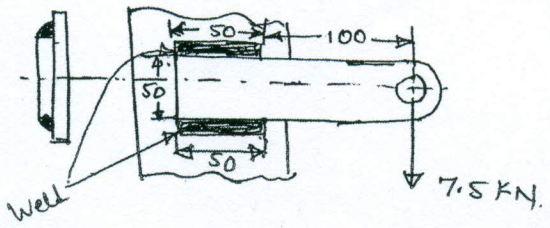

Fig. Q7 (a)

b. Design a double riveted double strap longitudinal butt joint, for a cylindrical steam pressure vessel of 1 m diameter subjected to an internal pressure of 2.5 MPa. The straps are of equal width. The pitch of the rivets in the outer row should be twice of the pitch of the rivets in the inner row. The rivets spacing has to be zig zag, between inner and outer rows, permissible tensile stress for the plates of vessel is 80 MPa and permissible shear stress for the rivets is 60 MPa. Assuming joint do not fail by crushing, determine the major dimensions and efficiency of the joint, which should be at least 70%. **(10 Marks)**

8 a. What is self locking screw? Show that efficiency of a square threaded self locking screw is less than $\frac{1}{2}$ or 50%. **(05 Marks)**

b. It is required to design a double start screw with square threads for the C-clamp shown in Fig. Q8 (b). The maximum force exerted by the clamp is 5 KN. It is assumed that, operator will exert a force of 250 N at the ball handle of the hand wheel. The screw has a nominal diameter of 22 mm, normal series square threads with 5 mm pitch and is made of 45C8 steel and the nut is made of FG200 cast iron. The mean diameter of collar friction is 12 mm and the bearing pressure between nut and screw may be assumed as 15 MPa. Check whether stress are safe and determine the radius of hand wheel. Assume a thread friction of 0.15 and collar friction as 0.17. **(15 Marks)**

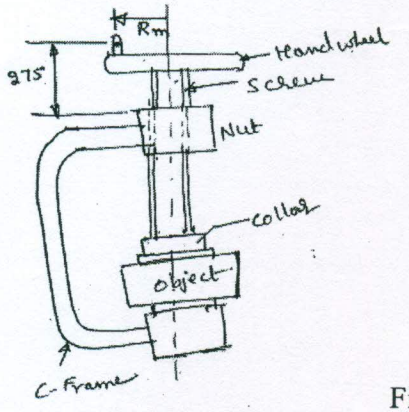

Fig. Q8 (b)

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